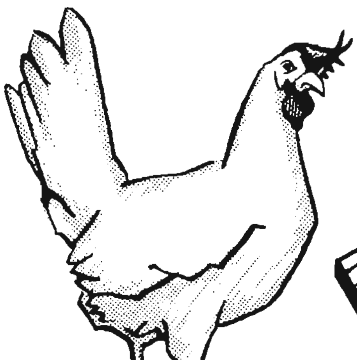
Ventilating poultry laying houses



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VENTILATING POULTRY LAYING HOUSES

How to build and use natural and forced ventilation systems . . . . **M. G. Cropsey**

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REPORTED in the publication are details on the following recommendations for proper poultry house ventilation:

- For summer ventilation, use natural methods of cross ventilation through the building or across the building. If fan ventilation is used, maintain 15 to 20 air changes per hour.
- For winter ventilation, provide five to eight changes per hour by fans. If natural ventilation is used, provide enough ventilation to remove excess ammonia fumes.
- Use management systems that concentrate droppings away from the litter, such as placing feeding troughs and drinking fountains on roosts.
- Use a deep built-up litter with lime that will absorb moisture during extremely wet weather, and can dry off during the drier weather. Stir the litter when it becomes packed.
- If forced ventilation is used, provide good circulation within the building by having enough fans located at 40-foot intervals or less on the windward side of the building, near the ceiling. Additional fan circulation inside the building sometimes may be necessary to take care of any dead spots. Provide exhaust openings on the lee side of the building at the same interval as the fans.
- For natural ventilation system use the following:
  1. For buildings 20 feet or less in width, provide ventilator types 8*d*, *e*, or *f* for front of building and type 7*c* for rear of building. (See Figures 7 and 8.)
  2. For buildings greater than 20 feet in width provide—
     With roosts at the rear, provide ventilator types: 7*a* or *b*, and *c*, and 8*d*, *e*, or *f* on the front side.
     With roosts in the center, provide ventilator types: 8*d*, *c*, or *f* on both front and rear of house.
  3. Provide circulation in winter that is just enough to remove excess poultry odors.
  4. If wet litter still results, insulate the roof or ceiling until the inside air temperature averages 15° F. to 20° F. higher than the outside temperature.
- For fan ventilation systems use the following:
  1. During extremely cold weather, cut down the rate of fan ventilation about one-third. This can be achieved by switching off a few of the fans or partially covering over the fans on the exhaust side.
  2. Use enclosed fan motors that require oiling at infrequent intervals.
  3. Provide guards around fans to prevent poultry from flying into them and to insure protection from rain.

Reasons for Ventilation

Poultry houses are ventilated in summer to cool them and to remove excess dust and lint. It is important to get a through circulation of air. This can be done by keeping walls open on both sides or providing circulation through the ends of a building.

The rate of ventilation in summer should be considerably higher than that of winter. This requires a larger fan for summer ventilation than for winter use. Normally 15 to 20 air changes per hour are required to achieve satisfactory cooling and removal of lint and dust in summer.

Insulation in the roof or ceiling reduces the rate of conduction of heat rays from the sun. This will result in a cooler house. Figure 1 suggests methods of keeping a laying house cool in the summer. Insulation of the roof and cross circulation of air are the most effective in cooling a house.

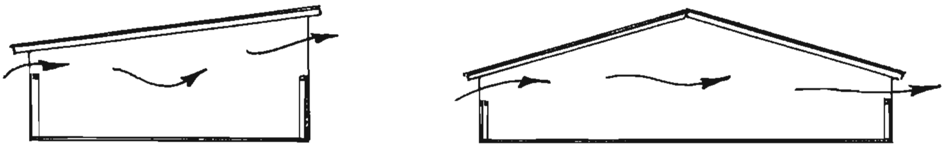

FIGURE 1. Make use of cross ventilation in summer.

Winter Ventilation

Poultry houses are ventilated in the winter to remove excess moisture, odors, and carbon dioxide in breathing as well as helping to maintain dry litter.

The amount of air required to remove excess carbon dioxide from respiration is very low, being 4.2 cubic feet of air per chicken per hour, according to Mitchell and Kelly.* For the average poultry house this is about one-seventh of a complete change of air per hour, which is far lower than the requirements for removing excess odors or retaining dry litter.

The presence of excessive odors indicates insufficient ventilation. Odors depend, to a certain extent, on the per cent of moisture in the litter. Wet litter produces ammonia fumes. A poultry house is not expected to be as free from odors as the inside of a human shelter; nevertheless, when there are less than five air changes per hour in a poultry house, odors will become excessive. Five air changes per hour should be the lower limit of ventilation for poultry houses during the winter, except for very cold weather.

Ventilation can assist in maintaining dry poultry litter. If good management practices are followed, and the poultry house built to take advantage of good ventilation, reasonably dry litter can be expected.

Why litter becomes wet

In a normal winter, western Oregon has air temperatures averaging close

* "Estimated Data on the Energy, Gaseous, and Water Metabolism of Poultry for Use in Planning the Ventilation of Poultry Houses." *Journal Agricultural Research.* 47:735-748.

to 40° F. which is 90 per cent saturated with water. If this air in a poultry house is changed five times per hour, it will pick up all the moisture chickens breathe out. This air will be nearly 100 per cent saturated with water. It will not pick up moisture in droppings. Moisture in droppings amounts to about one-quarter pound per day per bird. For 100 chickens, this would be equivalent to pouring 3 gallons of water over the litter. *The principal cause of wet litter in the winter is water in the droppings.*

Ventilation can help insure dry litter

For water in droppings to be evaporated and picked up, the air must be sufficiently dry; i.e., it must have a low relative humidity. As a rule, it should be about 80 per cent relative humidity or less to accomplish much drying. At temperatures of 30° and 40° F. air becomes saturated with very little water, while at higher temperatures it will hold more water. See Table 1 next column.

Table 1. Amount of water air will hold for 10,000 cubic feet of air

30° F.	2.8 lbs.
40° F.	4.1 lbs.
50° F.	5.9 lbs.
60° F.	8.3 lbs.
70° F.	11.5 lbs.

For example, the air in a poultry house becomes saturated at 40° F. If it were possible to raise the temperature 20 degrees to 60° F., the air would be only 50 per cent saturated. Under these conditions, the air could easily evaporate water from the droppings. *Raising the temperature 20° F. roughly doubles the water-holding capacity of air.*

Each chicken gives off about 40 b.t.u.'s of heat above the requirements for life processes. *The heat from chickens can be used to raise the air temperatures favorable for drier conditions, provided the ventilation is right and the house is sufficiently insulated.*

In a poultry house, both ventilation and insulation determine the inside rel-

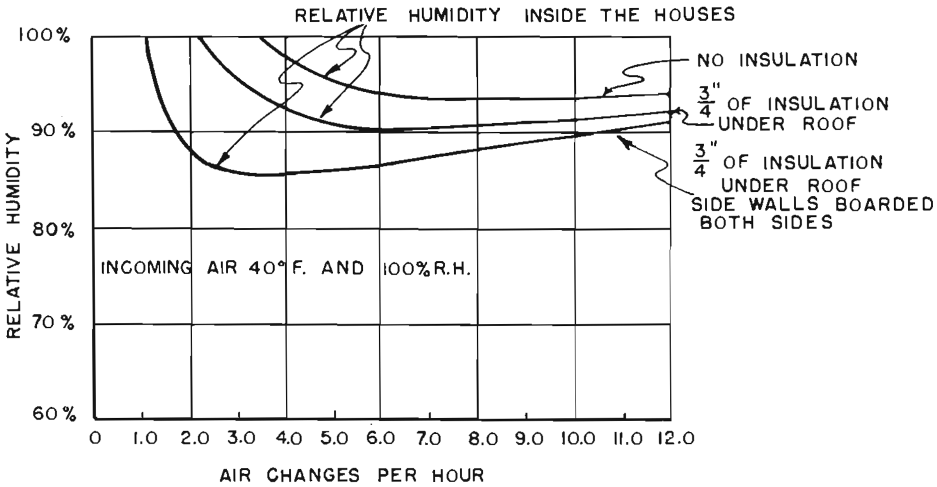

FIGURE 2. The effect of insulation on relative humidity.

ative humidity. A very lightly constructed house with single walls and no insulation loses heat rapidly. Under these conditions, reliance should be placed upon good management practices: deep litter, use of lime, and placing drinking fountains and feeding troughs on roosts.

An insulated house can retain enough heat from birds to raise the inside temperature to a level where relative humidity is low enough to keep the litter dry (see Figure 2). Ventilation should be from five to eight air changes per hour. Less than this amount will cause excessive odors in the house. With more ventilation than this, in cold weather, the temperature will be reduced resulting in a lower moisture-holding capacity for air in the house. Litter will not dry under these conditions.

Ventilation is given in terms of air exchanges per hour rather than cubic feet per minute per chicken. If the normal poultry house is filled to a capacity of about 3 square feet per bird, there will be only a slight difference in the air requirement, with a few less birds. Only when there is 50 per cent or less chickens will it make a great deal of difference.

Ventilation in cold weather

During very cold weather in western Oregon (10° F. to 20° F.), the air is able to hold less moisture than at higher temperatures. In a lightly constructed house the litter also tends to freeze. Any poultry droppings accumulating during this time will freeze. Nearly all the moisture in the droppings collects as frozen litter. During the first warm days that the litter thaws it becomes a very wet, soggy mass.

A properly insulated and ventilated house will help prevent this condition. Poultry give off more heat as the temperature becomes colder. Also, at lower temperatures less ammonia fumes are produced. By reducing the rate of air exchange, more of the heat is retained. This will result in drier air inside. If the house is properly insulated and the ventilation right, litter will not freeze.

Ventilation should be reduced about one-third during a cold spell. This can be accomplished by closing about one-third of the intakes, exhausts, or fans. As soon as warm weather returns, ventilation can be returned to normal.

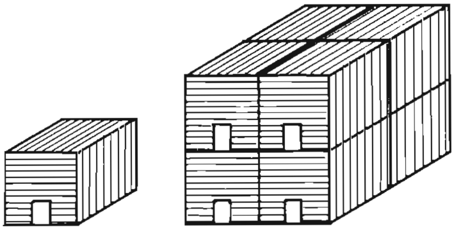

FIGURE 3. When you double the size of the house in all dimensions you have only one-half the surface area per unit volume to lose heat.

Construction items that keep litter dry

Moisture in droppings makes the litter wet. Thus, every effort should be used to concentrate droppings away from the litter. Placing feed troughs and drinking fountains over roosts will help. In addition, if drinking fountains are not placed over the roosts, they should be placed over a screened, concrete drain, or inside concrete pipe, etc. This will prevent water from running over the floor and being scattered by the chickens. (See Figures 5 and 6.)

Use a built-up litter

A built-up litter promotes dryness. It acts as a large sponge that can absorb water during damp periods of high humidity and can dry out during periods of low humidity.

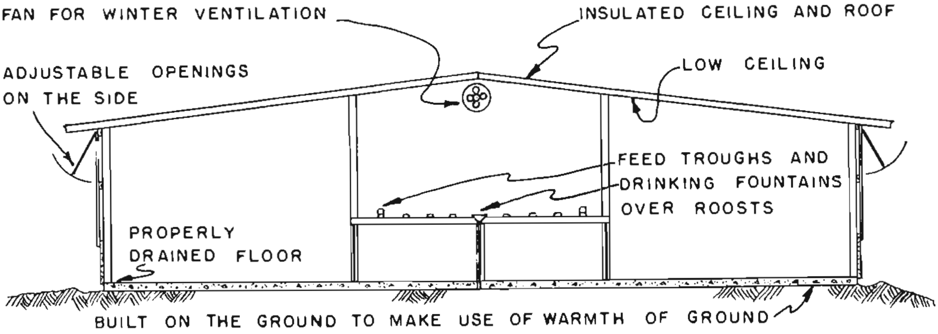

FIGURE 4. Construction features that will help maintain dry litter.

Adding air-slacked lime can help improve the litter. Chemically, a small amount of water can be absorbed by the lime. Also, lime tends to prevent packing of the litter and keeps it open so the air can help the drying process.

A built-up litter should be started early in the fall. At regular intervals lime and litter should be added to make a deep, well broken-up mass. As wet weather sets in, litter should be stirred at intervals to prevent its packing. A warm, properly ventilated house will require less stirring than one that is lightly constructed. Stirring can be accomplished by the chickens, by hand, and by litter stirrers. Feeding scratch grains in the litter is beneficial in keeping litter stirred up.

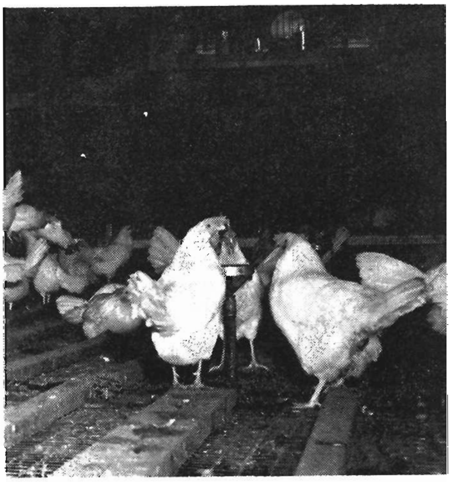

FIGURE 5. A drinking fountain placed over the roosts.

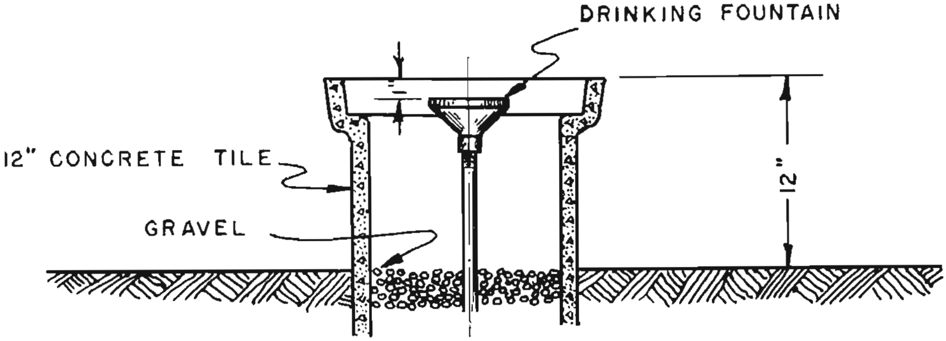

FIGURE 6. How to build a drinking fountain to prevent water spillage.

Methods of Ventilating

There are two general types of ventilating systems. The naturally ventilated systems, and the forced, or fan types. Both systems can be satisfactory if operated carefully. Naturally ventilated houses have to be watched closely for changes in wind velocities. Fan-ventilated houses may have power failures.

Natural ventilation systems

There are many satisfactory devices used in natural ventilation systems. (See Figures 7 and 8.) The important objectives are to supply the proper amount of air without draft. As a rule, vents which allow outside air to enter the building up high have a better chance of mixing with warm air before it settles on the birds. Thus drafts can be avoided. Deflectors over the roosts also prevent drafts.

It is difficult to specify the number and size of openings required for natural ventilation systems. Shape of the house and its location have much to do with velocity of air movement. Arrangement of roost and other interior fixtures may also alter the ventilation intakes. Direction of the prevailing wind and rain should be taken into account. It is safer to build into a house far more than the necessary number of vents and then close them for proper ventilation. The following recommendations are based upon the maximum ventilation necessary under most conditions to enable an operator to adjust openings until a desired ventilation is obtained.

For houses 20 feet in width or less, a 2 to 3 foot high opening along the front of the building, that may be adjusted, and an 8-inch opening along the entire back side of the building generally will be found adequate. Adjustments can be made in the back with ventilator type *7c* (Figure 7); those in the front by a window or a sliding panel, ventilator types *8d*, *e*, or *f* (Figure 8). For buildings greater than 20 feet in width, either openings in the back should be increased in size or roof ventilators of type *7a* or *7b* should be used. The choice will depend largely upon roost arrangement. As a rule, if roosts are placed in the center of a house, openings can be increased in the rear to as much as 2 or 3 feet, similar to the front openings, types *8d*, *8e*, or *8f*. If roosts are in the back, roof ventilation types *7a* or *7b* should be used.

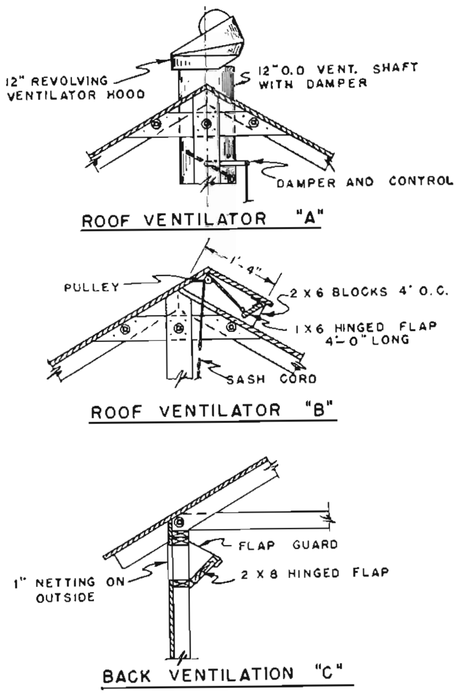

FIGURE 7. Natural ventilating devices. Roof and back type.

Type *7a* should be used at the rate of one 12-inch ceiling ventilation per 125 birds.

Forced ventilation systems

There are two general types of forced ventilating systems—the exhaust fan and the push-in type. A system based on fans pushing the air inside is recommended. The push-in type of system has the following advantages: the air is under pressure, and consequently cold air does not blow in through various cracks, which tends to make drafts in the building. For the push-in type ventilation system, air will be exhausted out through these small cracks. Fans also remain cleaner with the push-in type system. Clean outside air is handled by the fan instead of dusty inside air, as would be the case with exhaust fans.

A good distribution of air is maintained if adequate outlets are provided along one side of the building and fans are placed on the opposite side of the building. (See Figure 9.) The number and location of fans depend entirely on the size and shape of the house. In small pens, divided structurally by wood panels, perhaps the best results are obtained by single-wall fans for each pen. These fans should be placed on the windward side near the ceiling. A small exhaust hole, about the size of the intake fan, should then be placed on the lee side of the wall, preferably near the ceiling. This is to allow for air exhaust. Many times this can be obtained with a drop-back window. In a larger type house, a series of fans placed along the windward wall with exhaust openings on the leeward side offer the best possibility. On a square building, normally any side or end can be used satisfactorily, provided it makes use of the prevailing winds. As a rule, fans, as well as exhaust openings, should not be placed more than 40 feet apart.

Provide adequate circulation

Provide a thorough mixing of the air without dead spots within the building by proper distribution of inlets and outlets around the building. In some special instances, it might be best to insure air circulation by down-draft fans. Any fans of this type should be adequately guarded to prevent poultry from flying into them.

Proper fan size

Fan size can be found by multiplying the volume of the house in cubic feet by five and dividing this figure by 60. This will give the required fan capacity in cubic feet per minute to obtain five air changes per hour. If this one figure is larger than the average sized fan, then several fans can be used. For example, if a poultry house is 50 feet long and 30 feet wide, with an average ceiling of 8 feet, the inside volume will be $(50)\ (30)\ (8) = 12{,}000$ cubic feet. Five air exchanges will be five times this amount, $(12{,}000)\ 5 = 60{,}000$ cubic feet. Fans are rated in cubic feet per minute, so $\frac{60{,}000}{60} = 1{,}000$ cubic feet per minute. One fan of 1,000 cubic feet per minute or two fans of 500 cubic feet per minute would be satisfactory. This fan should be kept on day and night and not stopped. Adequate exhaust area should be provided on the lee side of the building. These exhaust areas should be equivalent in area and number to the fans.

It can be seen from Figure 2 that there is some flexibility in capacity. In other words, the air changes can vary from five to eight per hour. This will allow for differences when the fan sizes do not exactly meet the calculated figure. Always buy fans with a capacity a little greater than the calculated figure if an exact fan size can not be found to equal the calculated figure.

Type of equipment

Fan motors should be of an enclosed type. (See Figure 10.) This is necessary to prevent the dust and lint from coming inside the motor. Fans should be of the type that do not need lubrication very often, if at all. There are some fans that require no lubrication, and others that require lubrication only occasionally. It is suggested that the poultryman secure a type that needs only occasional lubrication.

Ordinary disc-type propeller fans are very satisfactory. Multiblade turbine fans work very satisfactorily, but

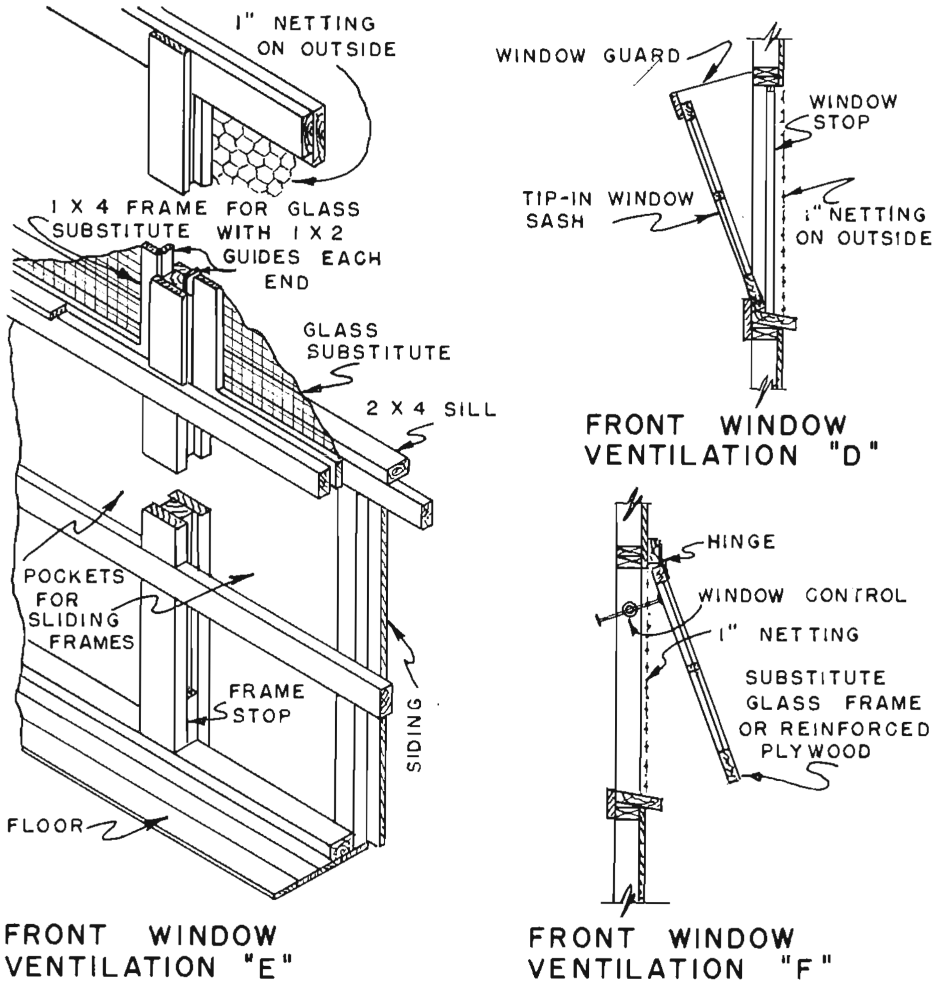

FIGURE 8. Natural ventilation devices. Front type.

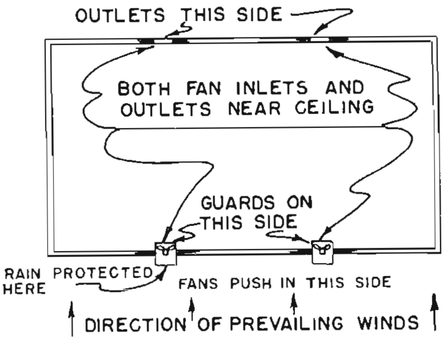

FIGURE 9. Location of fans.

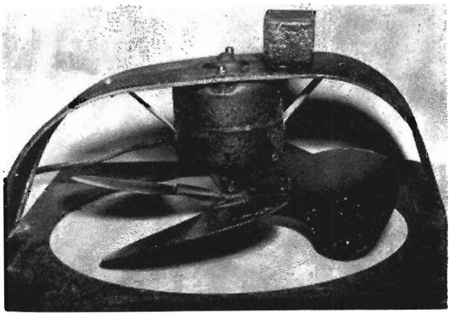

FIGURE 10. An enclosed-type fan motor.

they are generally too expensive for the average poultry man.

Protect your fans

All types of fans should be protected to prevent poultry from flying into them. Large mesh screens are generally adequate for this purpose. Provide canopies over the outside to prevent rain from driving in on the fans. Water is very apt to short out the motor electrically.

Insulation

Insulation in the roof or ceiling, large houses, low ceilings, and warm floors offer the greatest possibility in keeping a poultry house warm.

Most of the heat lost (other than that lost by ventilation) is lost through the ceiling. Warm air rises next to the ceiling, and by conduction heat passes out through the roof. Any insulation at the ceiling will help keep the house warmer and therefore drier.

A large poultry house has less square feet of exposure per unit volume than a small poultry house (see Figure 3). A large poultry house is, therefore, warmer, and can more easily raise the inside air temperature to a level where it can absorb moisture.

A low ceiling keeps the heat down next to the floor where it will do the most good. Warm air naturally rises and stays near the ceiling. A low ceiling will tend to keep the warm air nearer the floor.

A cold floor will condense moisture in the same manner as a window pane. This can be a cause of wet poultry litter. Single wood floors are perhaps the coldest type of floors. Use of a deep litter will tend to make the surface of the litter warmer. Litter should be from 6 to 8 inches to be of benefit. To prevent wood floors from rotting, they should be painted with pentachlorophenol, copper lignum, or some other wood preservative.

As a rule, concrete floors take on the temperature of the earth, which is not too cold in western Oregon. Concrete floors may become wet from water beneath the floors. A waterproof membrane should be built into the concrete floor to prevent water from passing up through the floor. Also, drainage around a concrete floor should be adequate to prevent water from collecting beneath the floor.

Enough insulation?

You can determine if there's enough insulation by first closing the house in winter for the average weather and providing five air changes per hour by fan. With naturally ventilated houses, ventilation should be limited to that which removes only excess odors. If the inside temperature is not an average of 15° or 20° warmer than the outside temperature when the house is filled to capacity, adding more insulation will help. (This average temperature should be the average of the morning and evening temperatures.) Add insulation under the roof or in the attic. Lower ceilings also will help. Keep the floors warm with deep litter and prevent excess ventilation beneath the floors. (Some ventilation should always be allowed beneath wood floors to prevent rotting.)